Performance Measurement Plan

Checkout and Launch Control Systems (CLCS)

84K00010

Approval:

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NOTE: See "**Supporting Document Note**" on following page

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Supporting Document Note: Acronyms and definitions of many common CLCS terms may be found in the following documents: CLCS Acronyms 84K00240 and CLCS Project Glossary 84K00250.

REVISION HISTORY

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PERFORMANCE MEASUREMENT PLAN

CHECKOUT AND LAUNCH CONTROL SYSTEMS (CLCS)

1. INTRODUCTION

The current Launch Processing System (LPS) supporting the Shuttle Program is 1970's technology. It suffers from reliability and obsolescence problems and has serious expansion limitations. The Checkout and Launch Control System (CLCS) will replace the current LPS with state-of-the-art technology. Best products from industry and government agencies will be combined to provide a showcase CLCS at the Kennedy Space Center.

CLCS is a NASA-managed, re-engineering activity, with contractor support provided under existing NASA contracts: the Space Flight Operations Contract (SFOC), the Mission Systems Contract (MSC), the Engineering Development Contract (EDC), the Base Operations Contract (BOC), and the Payload Ground Operations Contract (PGOC). The majority of the contractor support will be provided by the SFOC contractor, United Space Alliance, and the MSC contractor, Lockheed Martin Space Mission Systems and Services.

The CLCS Project is funded by and operates under the auspices of the Space Shuttle Program (SSP). Funding for CLCS is carried as a Launch Support Equipment (LSE) line item under the responsibility of KSC's Director of Shuttle Processing.

The CLCS Project is an application of state-of-the-art technology and is not driving the formulation of new technology. CLCS has an aggressive, success driven, product oriented, five-year schedule with deliveries to the end user every six months. Each incremental delivery provides an additional system capability that is built on top of the previously delivered capabilities.

2. PURPOSE

With an aggressive, success driven, product oriented, five-year schedule, CLCS is in full realization of schedule risk. CLCS is an extensive software effort with software development being the major portion of the labor effort. CLCS will be deployed primarily using Commercial Off the Shelf (COTS) technology. Therefore, labor associated with software development represents the majority of the project's cost and most likely will entail the majority of the project's cost risk.

Cost & Schedule Control Systems & Technical Performance Measure Tracking serve as valuable tools for tracking risk of these key project parameters. Performance measurement for CLCS involves two phases, planning (Section 3) and control (Section 4). The Planning Phase defines the baseline for the CLCS project. The Control Phase involves comparing actual cost, schedule, and performance criteria against the baseline, or against the plan. The CLCS Performance Measurement Plan provides the framework to analyze cost, schedule, and technical performance beginning with the Redstone delivery. The CLCS Performance Measurement Plan has been developed with guidelines which will enable the preparation of a brief, but accurate, report to provide insight to the overall performance of the project (i.e. issues, concerns, achievements, and meaningful status to Program Management). Cost, content, and schedule performance will be measured against the baseline project plan and will then be integrated and presented in a quarterly report to the SSP.

3. PLANNING PHASE

The planning phase integrates the project budget with the statement of work and the schedule. A time-phased budget baseline has been established to facilitate cost/schedule performance measurement and provides the budget structure to be used on the CLCS Project

The planning phase for CLCS began in mid June 96 when a Level III CCBD authorized a 60 Day Pilot Project dubbed New LPS (NLPS) . The 60 day analysis produced a M*anagement and Technical Volume* and a *Cost Volume* which together identify the project's initial baseline. When funding was authorized for the project, CLCS continued its planning phase in more detail. The *Master Project Schedule* (84K00008-001) further identifies and clarifies the schedule and technical performance goals. CLCS Project Management is responsible for the overall management of the CLCS Project and has accepted the responsibility to ensure that the CLCS Project is implemented in the most expeditious and cost-effective manner. The *Program Commitment Agreement* (84K00007) identifies specific cost, schedule, and technical performance commitments that the CLCS Project Management has made to the Shuttle Program. The *Work Breakdown Structure* (WBS) provides a logical outline and vocabulary that describes the entire project and integrates information in a consistent way. Periodic refinement and scrubbing of the WBS is an essential part of the budget process and the preparation of annual Program Operating Plan (POP) input. The System Level Specifications (84K00200) provide additional definition to the Management and Technical Volume and are critical to the ultimate acceptance of the system by the customer. Finally, the Concept Phase of each incremental delivery produces a Delivery Definition Document which establishes a 6 to 9 month near term plan defining products and threads that meet the project's goals, commitments, and budget. Although the major portion of planning and baselining is performed early in the project's life cycle, refining and updating plans as well as planning for and implementing contingencies continues throughout the entire process. The above CLCS products define the CLCS baseline which provides and defines the direction and destination of the project.

4. CONTROL PHASE

Performance measurement is a method of combining technical, schedule, and cost performance into one frame of reference. The intent of the CLCS Performance Measurement Plan is to provide a formalized, disciplined, and consistent approach to managing project activities.

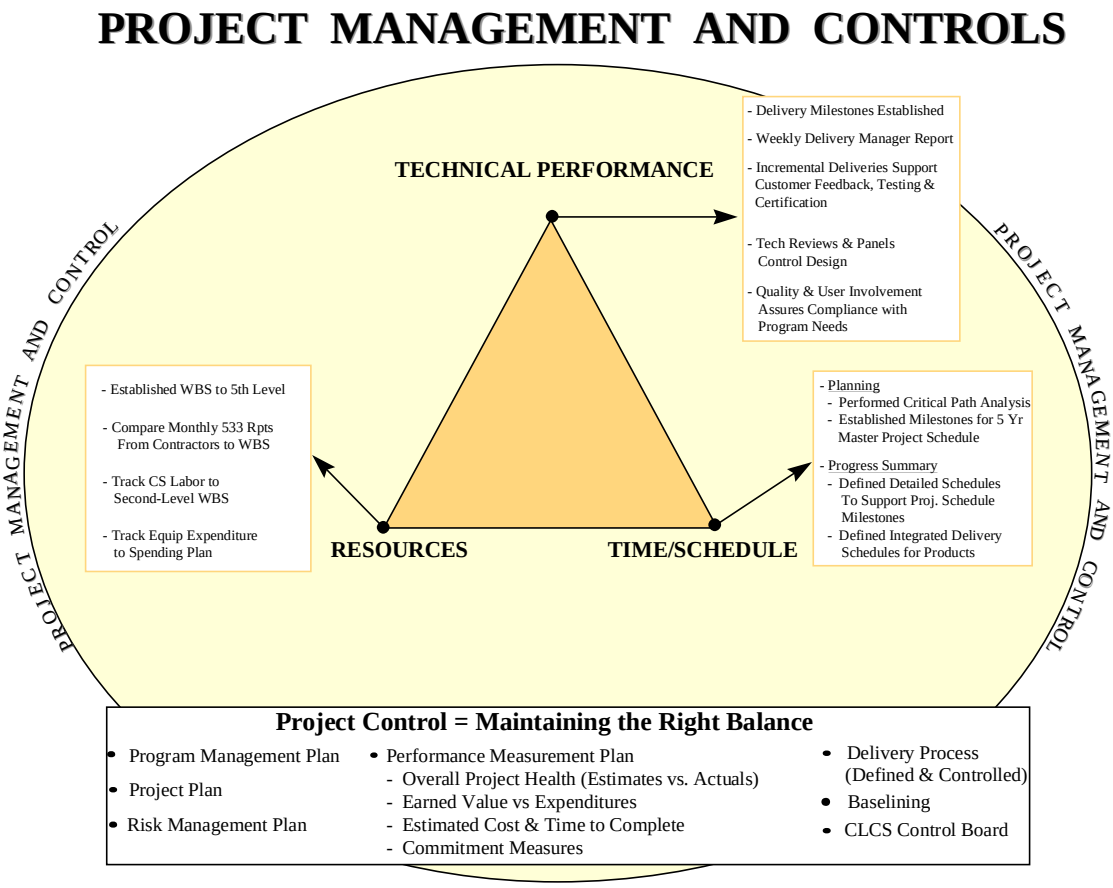

Figure 4-1 CLCS Management and Controls

Figure 4-1 illustrates the relationship between technical performance, resources, time/schedule, and management and controls. Additionally, this figure lists the major tools to be used in order to maintain the appropriate balance among these elements. Beginning with the second delivery, September 1997, the CLCS Performance Measurement Plan will be used to analyze cost, schedule, and technical performance. The Performance Measurement Plan will also identify and establish measurements to monitor the progress towards achieving the commitments described in the Program Commitment Agreement (PCA - 84K00007) and the Project Commitment Document (PCD - 84K00009). Any significant change to the project's cost, schedule or technical content will require an update to the PCA and the PCD. The CLCS Project Management Council (PMC) will judge the significance of changes of the project's key parameters.

Cost and schedule data will be analyzed against the:

- Management and Technical Volume
- Cost Volume
- Master Project Schedule

- Program Commitment Agreement
- Work Breakdown Structure
- Program Operating Plan (POP) input
- System Level Specifications
- Delivery Definition Document(s)

4.1 ELEMENTS OF THE CONTROL PHASE

4.1.1 PRINCIPAL TERMS

The principal terms used in measuring cost and schedule performance are the following:

Budgeted Cost for Work Scheduled BCWS Planned Work (Should do)

The BCWS is the total budgeted value of the work planned to be completed for any given reporting period. The BCWS therefore represents the budgeted values of all work scheduled at a point in time on the project baseline.

Budgeted Cost for Work Performed BCWP Earned Value (Did do)

The BCWP, also called Earned Value, is the total budgeted value for work which has actually been completed plus a portion of the budget for work that has been started but is still in process as of “time now”.

Actual Cost for Work Performed ACWP Actuals (Spent)

The ACWP is the amount of resources (dollars) that were expended to achieve the BCWP as of the same point in time.

Budget At Completion BAC

The budget that represents the total CLCS project (Statement of Work).

Estimate At Completion EAC

The EAC is the ACWP plus an estimate of the cost of remaining work.

4.1.2 PMS ANALYSIS USING PRINCIPAL TERMS

The following analysis will be performed and documented in the PMS report:

1. Schedule Performance Measurement: BCWP - BCWS = Schedule Variance Dollars

Based upon the relationship of BCWS to BCWP a schedule variance can be developed. BCWS is the budgeted effort to “time now” in terms of dollars. BCWP is the budgeted amount for the effort accomplished at “time now”. If there is no difference between these amounts, the work is on schedule.

Schedule Variance Percent = (BCWP - BCWS/ BCWS) X 100%

Positive variances indicate an ahead-of-schedule condition. Negative variances indicate a behind-schedule condition. Examples of causes for schedule variances are early receipt of material items, and resources not being available and expended later than planned.

Schedule Performance Index (SPI): (BCWP/BCWS)

The SPI is a ratio of work done to work scheduled, and is an indication of schedule efficiency.

2. Cost Performance Measurement: BCWP - ACWP = Cost Variance Dollars

The cost variance is based upon the relationship between BCWP and ACWP. It is a comparison of budgeted cost to actual cost incurred for the work physically completed.

Cost Variance Percent = (BCWP - ACWP/BCWP) X 100%

Positive variances indicate an underrun condition. Negative variances indicate an overrun condition. Examples of causes for cost variances are poor initial estimates for segments of work, technical difficulties requiring the application of additional resources, or cost of labor or materials being different than planned.

Cost Performance Index (CPI): (BCWP/ACWP)

The CPI is a ratio of work done to money spent, and is an indication of cost efficiency.

3. Variance At Completion (VAC): (BAC - EAC)

The VAC is a projection of final cost variance. A negative number indicates a potential overrun.

4. To Complete Performance Index (TCPI): (BAC - BCWP)/ (EAC - ACWP)

The TCPI is a ratio of work remaining to money remaining, and is an indication of projected cost efficiency.

5. Variance Analysis

The analysis of variances allows management to correct problems or to redirect efforts to avoid potential problems. The following variance thresholds have been established to identify significant variances that should receive additional management attention:

Schedule Variance Threshold: +/- 10% of BCWS
Cost Variance Threshold: +/- 10% of BCWP

An explanation of variances exceeding the established thresholds will include a description of the problem, the cause of the problem, the impact on the project, and the corrective action.

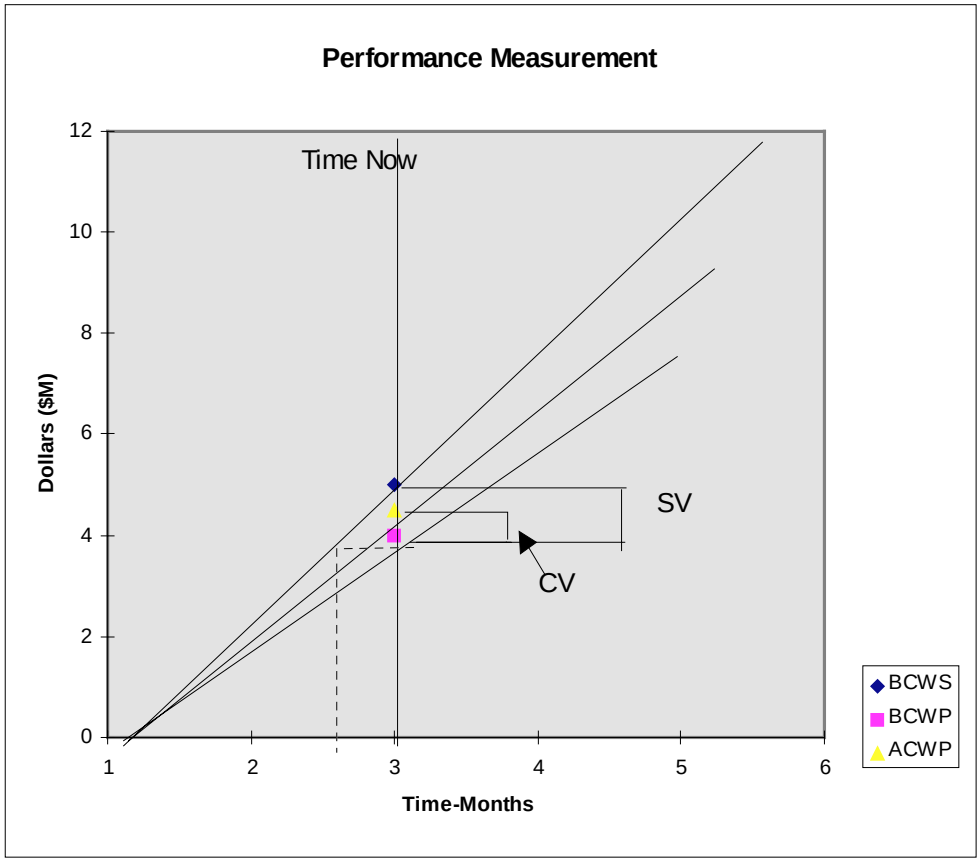

Figure 4.2 Example of PMS Analysis

4.1.3 EXAMPLE OF PMS ANALYSIS

Example of the type of PMS analysis that will be performed using the preceding formulas and illustration:

BCWS = 5M
BCWP = 4M
ACWP = 4.5 M
BAC = 175M

Schedule Variance = 4M - 5M = -1M, and indicates a behind schedule condition in dollars. In time, the illustration indicates a behind schedule condition of approximately 2 weeks.
Schedule Variance Percent = (4M - 5M)/5M X 100% = -20 %
Schedule Performance Index = 4M/5M = .8

Cost Variance = 4M - 4.5M = -.5M, and indicates an overrun to budget.
Cost Variance Percent = (4M - 4.5M)/4M X 100% = -12.5%
Cost Performance Index = 4M/4.5M = .89

For this example, the EAC = 4.5M + 171.5M = 176M

Variance at Completion = 175M - 176M = -1M, and indicates a potential overrun condition.

To Complete Performance Index = (175M - 4M)/(176M - 4.5M) = .997

In this example, an analysis of the cost and schedule variance would be required since the variance exceeds the

established thresholds. Figure 4.2 is a graphical illustration of this example analysis.

4.2 REPORTS - TIMELINE

Performance reports will fall into one of two categories: those developed quarterly, and those associated with incremental deliveries. Quarterly Performance Reports (QPR's) will be prepared within two weeks of receipt of the appropriate data. The incremental delivery approach of the CLCS Project will aid in the accuracy of assessing the percentage of completion of major elements of the project by breaking up long duration elements into smaller, more manageable and analyzable pieces. Delivery Performance Reports (DPR's) will be prepared within four weeks from each incremental delivery. The performance reports will integrate the time phased budget (BCWS) with accomplishments (BCWP) and actual cost of work performed (ACWP), and provide an analysis of cost and schedule performance. An explanation will be provided for significant cost and schedule variances. An EAC will provide an estimate of total cost at completion.

4.3 COST

Cost has been identified as a risk to CLCS. The majority of the hardware acquisitions are planned to be Commercial-off-the-Shelf products which mitigates the cost risk element in regards to hardware.

CLCS is a five year extensive software effort, and software development is the major portion of the labor effort. Keeping the project on schedule will in itself mitigate cost risks for labor. Incremental deliveries will add significant insight as to the achievement of "real" milestones and therefore attribute to the mitigation of this risk element. The basis of estimate for CLCS costs has been reviewed by program personnel from JSC and by the Non-Advocate Review team and it has been deemed to be adequate. In addition, the Shuttle program has established a reserve for the project of 20%.

Labor and non-labor costs are broken down and reported by each of the contractors supporting the CLCS Project..

4.3.1 OVERALL PLANNED VS. ACTUAL COST

Overall planned versus actual cost (labor and non-labor) and schedule data is published monthly and distributed in the Monthly Associate Administrators Review (MAAR) Package.

The MAAR Package contains information on project accomplishments, plans, issues/concerns, short term schedule, workforce, and cost. The requirement for this report is imposed by NASA Headquarters as a management tool for obtaining status on significant NASA programs. The information on CLCS is collectively prepared and reviewed by the CLCS Project Office and the Shuttle Resources Management Office. The MAAR Package is formatted by the Shuttle Resources Management Office, and signed by the CLCS Project Manager prior to submission to NASA Headquarters.

The MAAR Package presents the cost data in formats that provide: (1) a year to date total project summary; (2) KSC monthly and cumulative plan and actual cost; (3) KSC contractors and civil service plan and actual monthly FTE's; (4) JSC contractors monthly and cumulative plan and actual cost; and (5) JSC contractors plan and actual monthly FTE's. The KSC cost includes NASA planned and actual expenditures for CLCS hardware/software procurements.

The cost data from the MAAR Package and Program Operating Plan (POP) will be used for reporting plan and actuals at a project summary level in the performance report.

4.4 SCHEDULE PERFORMANCE

With an aggressive, success driven, product oriented, five-year schedule, CLCS is in full realization of schedule risk. The CLCS Project has adopted the concept of incremental deliveries to help in the mitigation of technical and schedule risk. By breaking the project up into smaller pieces, the incremental approach provides an accurate insight into overall project status and ensures that the system is delivered.

The involvement of the user community throughout the project's life-cycle is another key element to the project's success as this addition to the project team allows for early detection of latent flaws and quick turnaround of system fixes.

Project schedule status is reviewed on a weekly basis at a stand up meeting where the project delivery manager reports progress and issues to the CLCS project manager. The delivery manager obtains status by meeting weekly with the NASA and contractor lead engineers responsible for developing the products that provide the system level capabilities to be accomplished in the current delivery period. The stand up meeting also provides the opportunity for the NASA managers responsible for project integration to report on their perception of project status, issues, and concerns.

The CLCS project status also gets reported in a monthly presentation by the CLCS project manager to the Space Shuttle Program Manager.

The delivery products to be measured in the performance report will represent the six month incremental deliveries of the CLCS project.

The scheduling system is designed to provide accurate status report information that genuinely reflects the true status of work. It is intended for the content of delivery products to be clear and not subject to different interpretations as to when they are completed.

4.5 REPORTS - PREPARATION

A separate analysis will be performed on the labor effort and the NASA procurement activity related to the CLCS project. An analysis of the labor effort, including contractors' labor and non-labor costs, will be performed by applying the defined performance measurement formulas. This analysis will not include the NASA labor cost. However, the report will show planned versus actual NASA FTE's. The non-labor analysis will compare actual to planned expenditures for NASA procurements of hardware and software that are required for the total project.

Labor Analysis: the WBS will be the basis for allocation of FTE's for the six month incremental deliveries and the total project. The WBS allocates FTE's on a monthly basis. For this analysis, each monthly allocation consists of four equivalent weeks. Status report information will be used to determine if the project is proceeding according to schedule. The project will be considered on schedule if the final design panel for the six month incremental delivery is completed at the time of the QPR. If not, a determination will be made as to the schedule impact based on the design panel status of each software deliverable that comprises the six month incremental delivery. The schedule impact will be the basis for deriving the adjustment to planned FTE's and a value for the budgeted cost for work performed.

There is some overlap in the performance of consecutive six month incremental deliveries. The work leading up to the first design panel for each incremental delivery overlaps the preceding delivery. The cost is negligible and considered in the planned cost of the preceding delivery. The schedule status of both the current and the next six month incremental delivery will be assessed in the DPR. The next delivery will be considered on schedule if the first design panel has been completed.

The value determined for BCWP, the planned and actual cost (BCWS and ACWP) derived from the MAAR Charts and POP, will be inserted in the formulas for performance measurement to complete the labor analysis.

Non-Labor Analysis: a comparison of the planned versus actual cost for NASA procurements in support of the CLCS project will be performed as part of the performance measurement report. An explanation will be provided for significant deviations as related to the annual cost plan and total project. The release of procurement actions is dependent on requirement definition, procurement lead time, and available funding. Procurement actions supporting multiple delivery schedules will be occurring at the same time on this project. The tracking of procurements has been established at the WBS level for the combined total of all delivery products. The contractors' non-labor cost (material, training and travel) is not part of this analysis.